6 Cost Analysis

This chapter presents estimates for capital costs and operating and maintenance costs for the APRCS. The cost estimates are based on the information gathered in the course of developing and analyzing the companion AA. The cost estimate reflects a level of understanding commensurate with the conceptual engineering work performed to date. The figures will be updated and refined if the study advances to the development phase and if a Tier 2 EIS is prepared.

This analysis presents only the capital and operating costs of the project. There is not yet an identified source of funding or a schedule for construction with which to define a financing plan.

6.1 Cost Estimate Methodology

Cost estimates were developed based upon the general alignment for the Yellow and the Orange corridor alternatives. For the purposes of this cost analysis, it is assumed that the Yellow Corridor Alternative is within or along ADOT or UP ROW, and the Orange Corridor Alternative would be located within ADOT or other private or public ROW. Costs may change depending on the eventual project-specific alignment. Although no corridor alternative has been selected as the preferred alternative, the generic passenger rail technology upon which estimates were based was a diesel multiple unit capable of higher-speed rail (up to 125 mph).

Capital cost estimates for a passenger rail system were prepared consistent with the level of detail available for each proposed alternative. The calculations took into consideration construction costs and annual operating and maintenance costs based upon the assumed intercity and commuter rail operating plan presented in **Chapter 4 – Transportation Impacts**. The capital cost estimates are presented in current year US dollars and were developed for opening year, horizon year (2035), and long-range future. The estimates were prepared using standardized costs based on current railroad industry unit prices. The estimated cost for intercity and commuter rail stations, train equipment, and yard and maintenance facilities are also included in the capital cost estimate at a program level.

The annual intercity and commuter rail operating and maintenance cost estimates are based upon current, similar rail operations located in the western US.

6.1.1 Capital Cost Methodology

For this Draft Tier 1 EIS, the cost analysis is at a high level, but is built upon the specific corridor context using the most appropriate information available. The following assumptions were made for the development of the rail capital and operating cost estimates for the APRCS:

- Average speeds for local and express service for planning purposes were used for each service level to calculate fleet size. A total of 40 minutes (20 minutes at each terminal) for trains is allocated for terminal turn-back time. One spare commuter train and one spare intercity train would be provided.
- Double track costs are estimated for all elevated segments and at-grade segments at locations where trains moving in opposite directions need a second track to pass. Rights-of-way to accommodate double track are assumed along the entire corridor.
- Train sets would consist of diesel multiple units with four vehicles for commuter train sets and eight vehicles for intercity train sets.
- Bridges, such as those across canals, streets, and some washes, are assumed to be 200 feet or less in length. Some bridges across freeways, washes, and wide roadways are assumed to be between 200 feet and 300 feet in length. Major bridges are estimated on a cost per linear foot basis.
- Universal crossovers consist of four turnouts arranged in sets of two to form single crossovers in opposite directions. Crossovers would allow trains to cross from one track to another and are located at terminal stations, connections to servicing and maintenance facilities, and at intermediate locations would allow trains to operate over only one track due to maintenance or a problem on the other track. It is assumed that crossovers would be spaced 5 miles to 10 miles apart.
- At-grade highway/railroad crossings would be rebuilt for higher train speeds and multiple tracks in accordance with federal and state regulations. Each at-grade crossing would be equipped with medians and quadrant gates (to prevent motorists from driving around the gates), constant warning predictors, concrete panel crossing surfaces, and all required signage and graphics.
- Construction would use the existing I-10 westbound frontage road from Grant Road to Eloy. Property acquisition or additional access would be required for properties affected by loss of access from the frontage road. Reconstruction of the Red Rock traffic interchange and Missile Base Road would be required, as well as new roadways providing access to the proposed Park Link Drive and Arizona Public Service power plant access road. Ina Road and Ruthrauff Road are currently being designed to accommodate a passenger rail alignment.
- Positive and centralized train control costs consist of cab signaling and automatic train protection and supervision.

- Passenger stations would consist of system hub stations located at terminals, regional stations at key junction points, and local stations located along the system. Local stations located in freeway rights-of-way would include pedestrian crossings and stairs/elevators for passenger access.
- Unit costs are based upon experience and industry source articles. Costs have been rounded up after allowing for inflation.
- A planning level contingency of 40 percent has been added to the construction cost.
- Preliminary ROW costs reflect anticipated expenditures for potential acquisitions based on a general understanding of underlying property impacts and ownership.
- Estimate includes construction of support facilities including a single maintenance and storage facility to be located near the midway point of the corridor

For purposes of the Draft Tier 1 EIS Cost Analysis, a broad list of items was defined and categorized by line segment, as summarized in the *Cost Analysis Appendix*. Cost types such as capital, operating, maintenance, etc. were estimated by segments and defined specifically for this cost analysis and summed to obtain the total estimate for each corridor alternative. Preliminary costs for both corridor alternatives are rounded to the nearest $100,000 for smaller capital items (e.g., minor culverts) and the nearest $500,000 for larger capital cost items (e.g., siding turnouts). Real estate acquisition costs have been divided into residential, vacant, business, and institutional, and further split into urban, suburban, and rural for all categories.

6.1.2 Operating Cost Methodology

At this stage of development, the operating costs assume operation of commuter and intercity services based upon the service levels used to forecast ridership.

- Annual operating and maintenance cost estimates are based upon the 2010 National Transit Database vehicle mile and train/bus hour costs, inflated by 3 percent per year to 2013.
- Station operating costs are estimates based on a percentage of the associated total capital cost.

6.2 Capital Plan

The capital plan generally sets forth the financing requirements for funding the capital element of any project developed as part of a future Tier 2 document. Because funding sources have not been identified to advance the study into project development, the capital plan is developed according to the level of conceptual engineering performed to date. Once a corridor alternative

and funding sources have been identified, a capital cost estimate and plan would be developed for the project-specific Tier 2 EIS document. At that time, the capital plan will identify and rely upon refined and updated revenue opportunities to maximize and leverage revenues. It will also incorporate review and integration of the capital cost estimates and implementation schedules, including the potential for phased implementation. (A conceptual phasing plan is presented in the companion Service Development Plan [SDP].) The capital plan will document any new assumptions about annual and total receipt of federal revenues based on feedback from FRA.

6.2.1 Capital Costs

The capital cost estimates for implementing a passenger rail system within each corridor alternative are shown in **Table 6-1** and **Table 6-2**. The capital cost estimates in 2013 U.S. dollars, excluding any finance charges, are between $3.8 billion and $4.5 billion for a passenger rail system within the Yellow Corridor Alternative and between $6.5 billion and $7.6 billion for a passenger rail system within the Orange Corridor Alternative and include the items listed in the tables. These figures represent the cost of building a passenger rail system in either of the corridor alternatives.

Table 6-1. Estimated Capital Costs for a Rail System within the Yellow Corridor Alternative

ADOT Intercity Corridor Alternative: YELLOW - UP Alignment				119.8 Route Miles	
FTA Major Standard Cost Categories	**Base Year Cost w/o Contingency (x000)**	**Base Year Allocated Contingency (x000)**	**Base Year Dollars Total (x000)**	**Base Year $ Percentage of Construction Cost**	**Base Year $ Percentage of Total Cost**
10 Guideway & Track Elements	$1,466,063	$111,935	$1,577,997	55%	35%
20 Stations, Stops, Terminals, Intermodal	$38,333	$63,963	$102,296	4%	2%
30 Support Facilities: Yards, Shops, Admin. Buildings	$148,000	$63,963	$211,963	7%	5%
40 Sitework & Special Conditions	$449,471	$95,944	$545,415	19%	12%
50 Systems	$356,060	$79,953	$436,013	15%	10%
Construction Subtotal (10 - 50)	**$2,457,927**	**$415,758**	**$2,873,685**	**100%**	
60 ROW, Land, Existing Improvements	$120,760	$127,926	$248,686		6%
70 Vehicles	$368,000	$95,944	$463,944		10%
80 Professional Services	$251,450		$251,450		6%
Subtotal (10 - 80)	**$3,198,138**	**$639,628**	**$3,837,765**		
90 Unallocated Contingency			$639,628		14%
Total (10 - 90)			**$4,477,393**		**100%**

6.2.2 Funding Sources

Currently no funding sources are identified for the construction and operation of a passenger rail system. Depending on the final governance structure for passenger rail in Arizona, revenue could come from various sources. For example, a commuter rail system within urbanized areas between Tucson and Phoenix metropolitan areas could request Section 5309 New Starts federal grants or local funding from regional and state agencies or from private interests. Intercity service would compete for different sources of funding at the state or federal levels. In either case, substantial funding would need to be generated within Arizona to seek matching federal dollars. Various such programs are being discussed such as FRA's High Speed Intercity Passenger Rail Program (or a follow-on program), but none is well enough defined to be considered viable yet. A detailed financial plan would be developed as the study advances to the development phase and a Tier 2 EIS is prepared.

Table 6-2. Estimated Capital Costs for a Rail System within the Orange Corridor Alternative

ADOT Intercity Corridor Alternative: ORANGE - I-10 / N-S / US 60 / 101L				128.5 Route Miles	
FTA Major Standard Cost Categories	**Base Year Cost w/o Contingency (x000)**	**Base Year Allocated Contingency (x000)**	**Base Year Dollars Total (x000)**	**Base Year $ Percentage of Construction Cost**	**Base Year $ Percentage of Total Cost**
10 Guideway & Track Elements	$3,291,156	$297,301	$3,588,456	67%	47%
20 Stations, Stops, Terminals, Intermodal	$70,833	$135,137	$205,970	4%	3%
30 Support Facilities: Yards, Shops, Admin. Buildings	$106,000	$108,109	$268,109	5%	4%
40 Sitework & Special Conditions	$614,884	$162,164	$777,048	15%	10%
50 Systems	$362,710	$135,137	$497,847	9%	7%
Construction Subtotal (10 - 50)	**$4,445,583**	**$837,847**	**$5,337,430**	**100%**	
60 ROW, Land, Existing Improvements	$51,620	$108,109	$159,729		2%
70 Vehicles	$400,000	$135,137	$535,137		7%
80 Professional Services	$454,262		$454,262		6%
Subtotal (10 - 80)	**$5,405,466**	**$1,081,093**	**$6,486,559**		
90 Unallocated Contingency			$1,081,093		14%
Total (10 - 90)			**$7,567,652**		**100%**

6.3 Operating and Maintenance Plan

Operating costs cover the maintenance and operations costs of running a passenger rail system within the corridor alternatives. The elements of this cost assessment include a high-level estimate of train operations, station operations, and the needs of the maintenance and storage facility that supports the passenger services.

Operating and maintenance cost estimates were prepared for each corridor alternative based on separate costs for intercity and commuter rail. **Table 6-3** lists the existing systems referenced as part of the cost calculations. Operating and maintenance cost estimates also included total costs for maintenance staff, equipment, and facilities using travel forecasts.

Table 6-3. Operating Costs for Existing Transit Agencies Using Commuter Rail Service

Existing Rail Transit Systems	Location	Annual Operating [8] Cost	Fixed Guideway[a] Directional Route Miles	Average Operating Cost/ Route Mile
Dallas Area Rapid Transit	Dallas – Fort Worth – Arlington, TX	$25,873,787	72.3	$357,867
Peninsula Corridor Joint Powers Board (Caltrain)	San Francisco – Oakland, CA	$97,555,152	153.7	$634,711
Massachusetts Bay Transportation Authority	Boston and surrounding areas, MA	$322,088,557	776.1	$415,009
Metro Transit	Minneapolis – St. Paul, MN	$16,419,740	77.9	$210,780
Tri-Met	Portland (Westside Express), OR	$6,486,920	29.2	$222,155
Tennessee Department of Transportation	Nashville, TN	$3,939,586	62.8	$62,732
Capital Metropolitan Transportation Authority	Austin, TX	$11,358,085	64.2	$176,917
Rio Metro Regional Transit District	Albuquerque, NM	$24,226,678	193.1	$125,462
Southern California Regional Rail Authority (Metrolink)	Los Angeles – Anaheim – Long Beach, CA	$171,572,964	777.8	$220,588
Central Puget Sound Regional Transit Authority	Seattle, WA	$36,762,712	163.8	$224,437
South Florida Regional Transportation Authority	Miami, FL	$55,588,137	142.2	$390,915
Utah Transit Authority	Salt Lake City – West Valley City, UT	$20,041,804	174.5	$114,853
Maryland Transit Administration	Washington DC	$97,050,916	400.4	$242,385
Virginia Railway Express (VRE)	Washington DC	$61,552,829	161.5	$381,132
MTA Long Island Rail Road	New York – Newark, NY	$1,163,468,650	638.2	$1,823,047
NE Illinois Regional Commuter Railroad Corp.	Chicago, IL	$627,591,444	980.4	$640,138
Metro North Commuter Railroad Company	New York – Newark, NY	$940,674,081	545.7	$1,723,793
New Jersey Transit Corporation	New York – Newark, NY	$869,846,760	1,001.8	$868,284
Southern Pennsylvania Transportation Authority	Philadelphia, PA	$255,004,244	446.9	$570,607
Shaded rows indicate rail systems that include both electric multiple unit (EMU) and diesel multiple unit (DMU)rail power		Average (includes EMU/ DMU transit systems)		$495,043
Note: [a]National Transit 2012 Database Transit Agency Profiles		Average (includes only DMU transit systems)		$269,996
		2013 Value		**$278,096**

Operating and maintenance cost calculations were based on the actual costs of existing rail operations throughout the country with similar characteristics to those planned within each corridor for this passenger rail system. The operating and maintenance cost analysis for a passenger rail system within the Yellow Corridor Alternative and Orange Corridor Alternative are shown in **Table 6-4**.

Table 6-4. Comparative Estimated Annual Operating and Maintenance Costs by Corridor Alternative and Service Type

	Yellow Corridor Alternative		Orange Corridor Alternative	
Service Type	**Intercity**	**Commuter**	**Intercity**	**Commuter**
Trip Length (miles)	119.8	119.8	128.5	128.5
One Way Trip Time, NB/SB[a] (minutes)	83/82	95/96	83/85	98/99
Number of Cars[b]	8	4	8	5
Fleet Size[c]	5	13	4	15
One-Way Trips per Weekday	16	56	16	56
Weekday Miles	1,916.8	6,708.8	2,056	7,196
Annual Revenue Miles[d]	498,368	1,744,288	534,560	1,870,960
Unit Cost [e-g] (Operating Expense per Vehicle Mile)	$29.79	$29.79	$35.75[h]	$35.75[h]
Estimated O&M[i] Cost	$14,846,383	$51,962,340	$19,110,520	$66,886,820
Total Estimated Annual O&M Cost	**$66,808,722**		**$85,997,340**	
Average Operating Cost/ Route Mile	$557,668		$669,240	

Notes:
[a] NB/SB= Northbound Trip / Southbound Trip
[b] Based on diesel multiple unit (DMU) train
[c] Includes 1 spare train for each rail service
[d] Weekdays only service assumes 260 operating days per year
[e] Operating Expenses per Vehicle Revenue Mile are in 2013 U.S. Dollars
[f] Operating Expense per Vehicle Revenue Mile from 2012 National Transit Database plus 3% inflation per year to 2013
[g] Operating Expenses per Vehicle Revenue Mile is based on the average value of 14 existing transit systems across the U.S. that have similar operations
[h] Operating Expenses per Vehicle Mile average cost inflated by 50% to take into account higher operating speed and structures estimated for this rail system
[I] O&M=Operating and Maintenance

As shown above, the estimated operating and maintenance costs are based on trip length, travel times, route miles, and fleet size for intercity and commuter service for each corridor alternative. The total estimated annual operating and maintenance cost estimates (based on 2013 U.S. dollars) are approximately $66.8 million for a passenger rail system within the Yellow Corridor Alternative, and $86 million for a passenger rail system within the Orange Corridor Alternative.

6.4 Cash Flow Plans

A cash flow analysis would be developed once a corridor alternative is identified during project development and when funding mechanisms with annual sources and uses of funds are defined. The cash flow plans would depend on the type of funding used to pay for construction and operations. Options include pay-as-you-go approach or debt financing construction or a combination of the two approaches. The selected approach could have differing effects on the timing of impacts (e.g., acquisition of adjacent properties or construction) and on the financial management of the program. These concepts would be further developed if a corridor alternative is identified during preparation of the Tier 2 EIS.

6.5 Financial Risks and Uncertainties

The greatest financial risk to developing a passenger rail system within either corridor alternative is the potential inability to secure funding for construction, operation, and maintenance. Other financial risks could include issues affecting or delaying property acquisition and the cost of property acquisition, the volatility of material costs, and their effect on the overall cost estimate. Another factor affecting the total cost estimate is the cost share among competing projects, such as the North-South Corridor, and how costs would be shared between modes.